



University of  
Sheffield



**ATLAS**  
EXPERIMENT

# Masterclasses in Sheffield and Germany + Bonus material (Virtual tours)

Dr Kristin Lohwasser  
Dr Scott Wilbur  
(University of Sheffield)



# Masterclasses in Sheffield

Time	Topic	Speaker	Duration
09:00 → 09:20	Welcome and Overview over the day	Kristin Lohwasser (University of Sheffield (GB))	20m
09:20 → 10:00	Introduction to Particle Physics	Michael Antony Postill (University of Sheffield (GB))	40m
10:00 → 10:15	Break		15m
10:15 → 11:00	Introduction to LHC and ATLAS	Kristin Lohwasser (University of Sheffield (GB))	45m
11:00 → 11:15	Break		15m
11:15 → 11:45	Studying physics	Davide Costanzo (University of Sheffield (GB))	30m
11:45 → 12:45	Lunch		1h
12:45 → 14:30	Hands-on		1h 45m
14:30 → 15:00	Results		30m
15:00 → 16:00	Videoconference		1h

**General comment on hands-on: to speed up things, everything needs to be download, opened, loaded (struggle to navigate folders, ....) → is quite some work to setup**

Just during International masterclasses and run as taster day (due to advertisement easiness and other advantages)

Relatively standard / boring setup through “talks” (small HEP group which is slowly getting geared up towards more hands-on/interactive outreach – but having hen&egg problem: Few people, few events, little occasion to get people trained up)

Including general recruitment talk on studying physics (Q&A)

We now had the first masterclass in Neutrinos (3 hour schedule) → could have some combined programme, but will need to adapt.

All based on international Masterclasses (as that sets a time/date for re-joining masterclasses)

# Comment on masterclasses in Germany

Differences to organisation in Germany:

- Germany-wide “Netzwerk Teilchenphysik” at Dresden Uni holds grant for organising masterclasses.  
→ hosted at Schools with PhD students traveling there from their respective Universities all over Germany (usually in pairs, potentially with postdoc, since crowd control can be an issue and they need assistance for the ATLANTIS ). Paid honorarium (~100 Euro/day) + travel.
- 1-2 main people on grant to develop outreach, network (also including teacher training) [one person at Dresden, one person at DESY both ~full time(?) for outreach activities] (!! → speculation!!)
- Very much based on international Masterclasses (co-developed by Uta Bilow in Dresden who also is the lead on the Netzwerk Teilchenphysik)
- School visits on-site are more challenging (crowd control!!) compared to single-people sign-ups to international masterclasses
- These experiences informed a bit set up in Sheffield (plus **lack of funding** though now in CG)

# Fully remote ATLAS tours

Based on experience with students (wowed by “random” facilitator at CERN but not asking many questions on “research life” to the local facilitators), attempt to develop fully remote ATLAS tour (as opposed to video link to CERN)

## Three major milestones / Objectives:

- 1) Development of interactive ATLAS VR model
- 2) Deployment of model within exhibition in the National Videogame Museum in Sheffield
- 3) Workshop on video game development with ATLAS VR as an inspiration

# Easiest to use as talk: webpage tour

## ATLAS experiment *(included in short version)*

Control Room, Visitor centre  
Cavern entry, Lift, toilets  
Cavern: *Detector from side, behind and top*  
Beam pipe,  
Muon system *from the side*, cabling  
Computing room



## CERN reception/tram stop

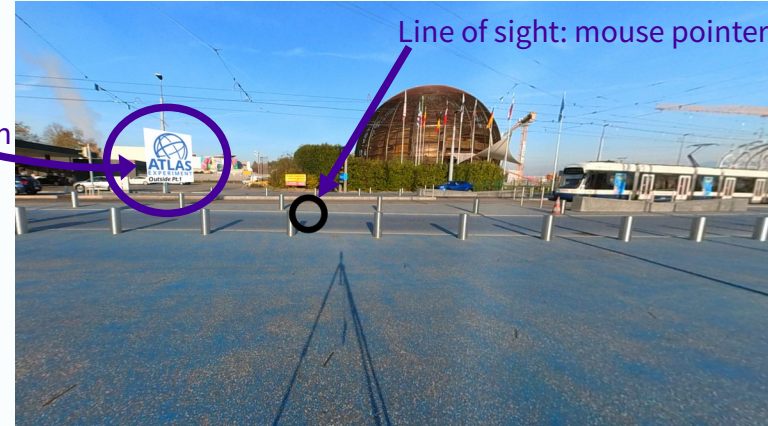
### CERN site

Office B1  
Canteen / R1  
Outside R1, outside B40  
B40 downstairs  
B40 office

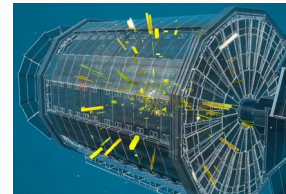


24 different scenes – works on oculus rift

Link to change to next scene (activated when in line of sight)



Line of sight: mouse pointer



Link to further information



<https://lhc-panoramas.web.cern.ch/lhc-panoramas/>  
ATLAS Collaboration DOI: [10.22323/1.390.0954](https://doi.org/10.22323/1.390.0954)

# Use cases: Exhibitions and Talks

Lightweight and cheap VR head set works well for exhibitions:

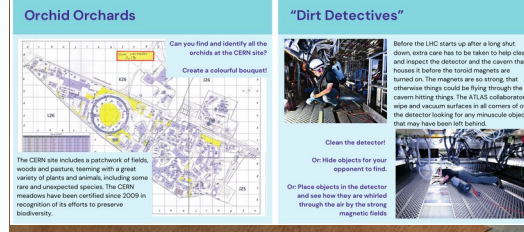
- STFC Daresbury lab open days
- Museum exhibition (+ATLAScraft, exhibition on physics in videogames and project on rigid body avatars)
- Stand up for STEM event



Webpage works for talks

- School visits, Pint of Science
- 

→ Over 3000 people reached



Invent a “CERN video game” poster  
Brochure with stops on short tour

## Brochure for short tour

**A Virtual Tour through the ATLAS Detector at CERN**

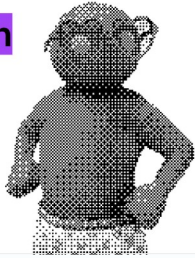
Explore one of the World's Largest Scientific Instruments

- The ATLAS Detector**  
The ATLAS detector is one of the four major experiments of the Large Hadron Collider (LHC) at CERN. ATLAS is like a gigantic microscope with a camera that can take 40 million pictures per second, each of 100 million pixels. It is a general-purpose detector designed to be sensitive to the widest possible range of physics at the LHC. The detector built as a cylinder, 46m long, 25m in diameter. Scavenging runs along the walls of the cavern around the detector on 13 levels. We start on the first floor with our tour.
- Head to the Third Floor**  
On the 3rd floor, just two flights of stairs up and on the opposite side, we can see the detector bit better. It has been opened up and the crystal has been moved out an orange support structures. This very large crystal contains the eight superconducting coils of the First Gap. Tended for the ATLAS magnets. When excited to the nominal current, 20000 A (low inductance) in the superconducting coils. Also, the Main Wheel is visible in full glory. This large structure looks like a flower in full bloom with golden-coloured petals radiating outwards. It is designed to direct muons – particles that deposit so little energy that they are not stopped in the inner parts of the detector.
- Up to the Top!**  
Finally we reach the top. Look up at the shaft, a huge hole used to lower parts of the detector down for assembly. A nerve-racking experience. It takes hours as the large parts are carefully moved millimetres by millimetres. The shaft is very narrow, and smashing a unique and irreplaceable part into the concrete wall would be fatal.
- The LHC Beamline**  
Then we take a look at the LHC beamline (blue pipe at the end of the shaft). The beams in the LHC are made up of bunches of protons, spaced seven metres apart, with each one containing more than 100 billion protons. The silver pellets are again parts of the muon detector (how seen from the other side).

Discover ATLAS on the web

# Workshops: ATLAS and Videogames

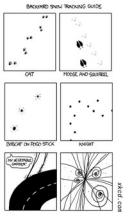
## A tour through the ATLAS detector



### Collisions & Decays

Once all particles of a collision have been measured and identified according to their unique "footprint", particle physicists can reconstruct, what happened in a collision by considering also combinations of particles that might stem from the decay of a heavier particle.

They can also convert the **count** of events of a certain type into a **probability** which is related to the strength of an interaction.

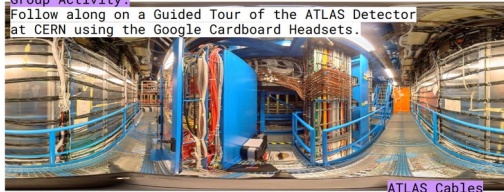


### A Group Effort!



### Take a Tour of the ATLAS Detector

**Group Activity:**  
Follow along on a Guided Tour of the ATLAS Detector at CERN using the Google Cardboard Headsets.



<https://www.hep.shef.ac.uk/dowasser/atlas-southsmalltour.html>

ATLAS Cables

## Structured workshop developed

- Collaboration with Leah Dungay (NVM)
- Targeting Y12 (16-18 year olds)
- 1 - 1.30 hours

## Combining ATLAS, VR tour and Videogames:

- Introduction to the ATLAS experiment
- Short tour through ATLAS
- Discussion of physics in videogames
- Hands-on design of videogame

Facilitated at National Videogame museum and University of Sheffield (Access to STEM program facilitated through central services)

Plan to develop version for younger audience

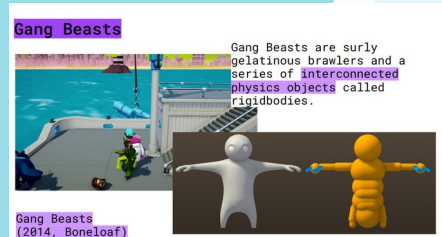
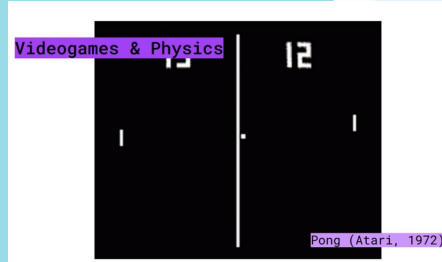
# Physics in Videogames

Physical behaviour in videogames driven by "Physics engine"

Differential equations describing e.g. shoots in FIFA series.

→ Improvement in maths led to significantly more natural reactions of the ball

Equations calculated for rigid bodies



## Genre

1. Racing
2. Sandbox
3. Puzzle
4. Multiplayer
5. Battle Royale
6. Platformer

## Goal

1. Escape
2. Survive
3. Reach Destination
4. Remove all Enemies
5. Rescue or Capture
6. Highest Score



# Feedback



Workshop tested with over 50 participants so far

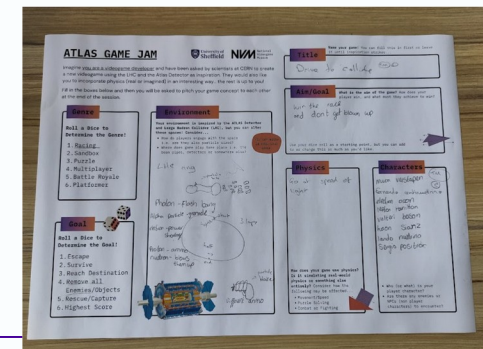
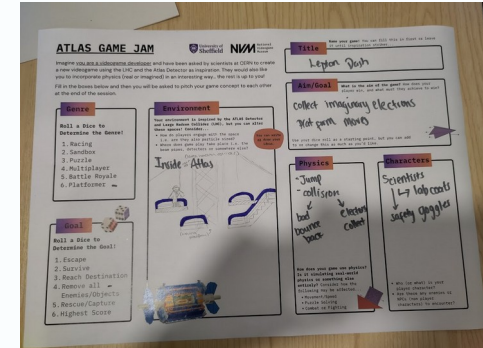
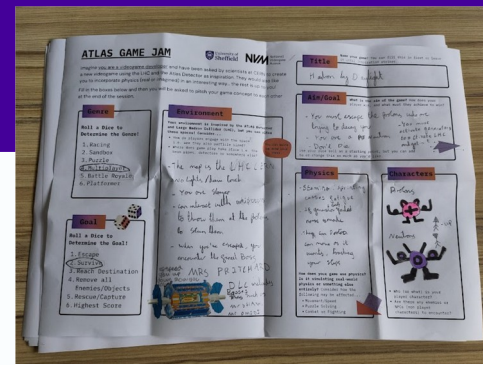
Feedback received from 25

Workshop rated as outstanding: 4,4 ★★★★★

Rated difficulty as 2.8 -  
right in between too hard (5) and too easy (1)

50% feel more likely to consider studying  
science for A Level or at university

50% feel they are more likely to consider a  
career in science



# Conclusions

Created new outreach materials suited for remote promotion of ATLAS

- Cheap and portable VR viewer
- Virtual tour website
- Hands-on Workshop on ATLAS and videogames

Good feedback from tours and workshops

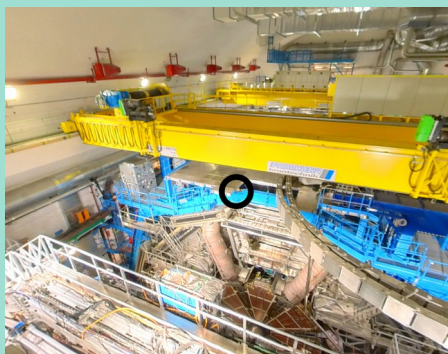
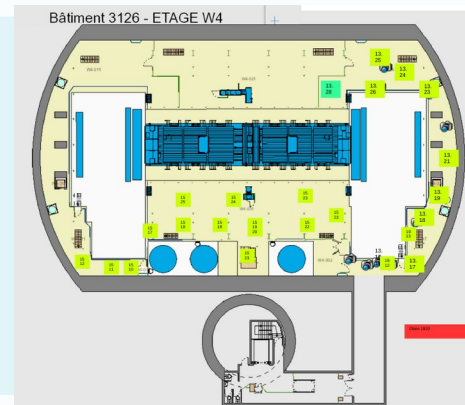
<https://www.hep.shef.ac.uk/lohwasser/atlas-tour/smalltour.html>  
[https://www.hep.shef.ac.uk/lohwasser/atlas-tour/fulltour/1\\_reception.html](https://www.hep.shef.ac.uk/lohwasser/atlas-tour/fulltour/1_reception.html)  
Feel free to contact for questions on the mobile phone app

# Backup

k.lohwasser@sheffield.ac.uk

# The tour

- Used InstaX3 (360 degree camera, borrowed from University media services)
- Took > 200 pictures from different places within the cavern (available within collaboration)
- Slightly worse quality (compared to e.g. LHC panoramas)



Compiled into tours of static scene using different means:

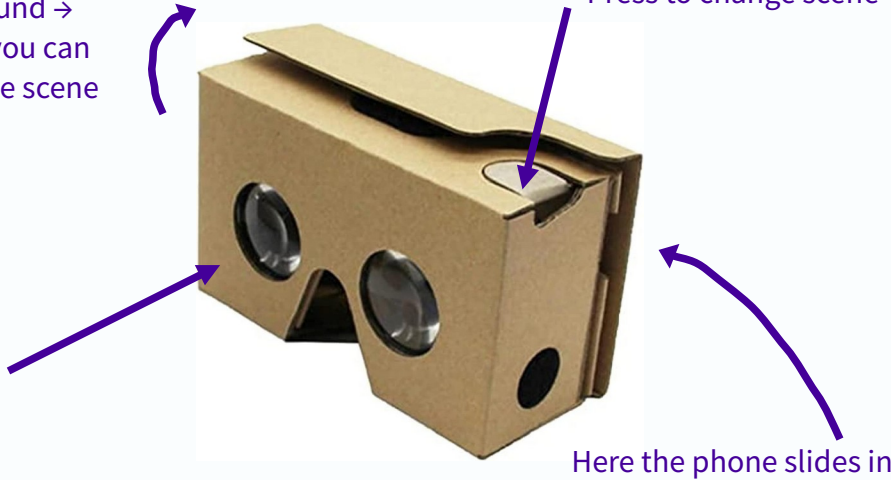
- Webpage (2 tour variations)
- Google cardboard (4 tour variations)
- Mozilla Hubs (discontinued)

# Google cardboard...

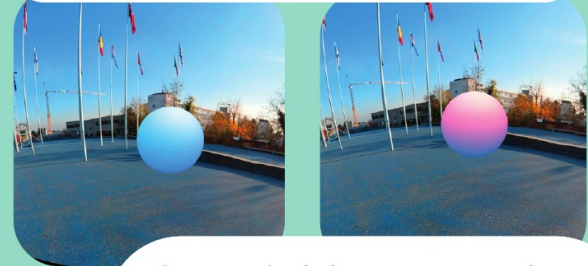
Move your head around → look up and down, you can look all around in the scene

Press to change scene \*

Look through here



To get started put the headset on and look around to discover the space.



Geometrical shapes are portals to the next scene – once you look straight at them, they change colour. Press the button when it turns pink to be transported.



Cardboard: 5 – 10 GBP

(plastic ones also available, but more expensive)

Phone 49.00 – 65 GBP

(Motorola Moto G5 16GB 2GB Unlocked XT1675 SINGLE SIM, Can be cheap specs, but **needs gyroscope!**)

Implemented using Unity game engine

Standalone .apk application for Android → phone can run without mobile/internet. Works ~4 hours without charging

# Difference in resolution

Left: InstaX 360 camera



Right: CERN 2-stereo HD camera setup

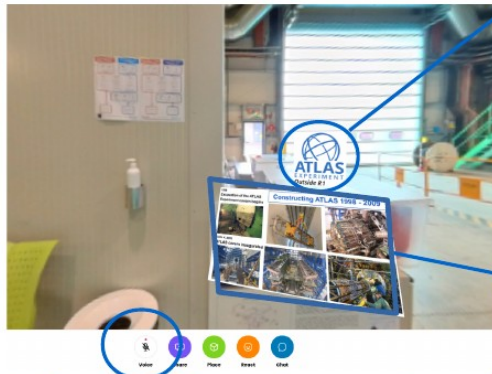


# Mozilla Hubs (goodbye...)

Discontinued service added possibility to interact via avatars and sound

You will be “teleported” into a scene at CERN, but clicking anywhere in the picture and holding the mouse button you can turn around, look up and down and all around. Exceptions are:

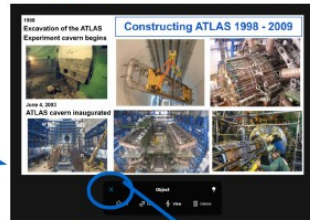
- 1) Portals
- 2) Media (Photo, Video)



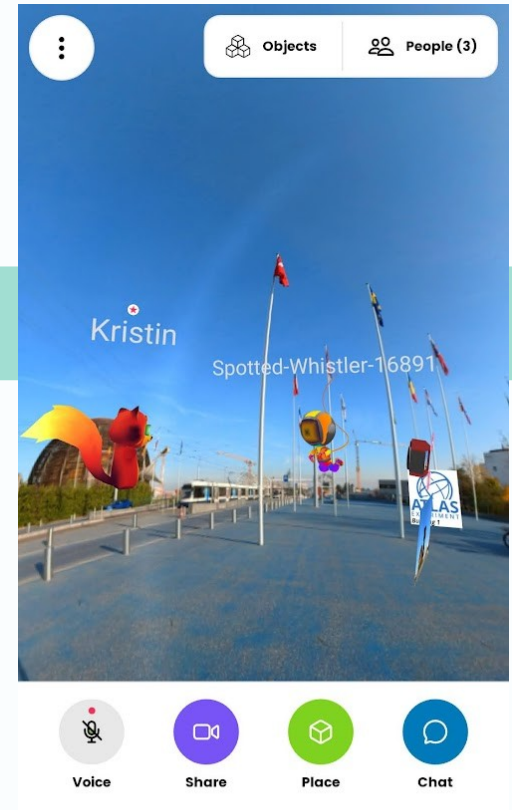
Let's keep muted unless you have a question (helps with performance), but feel free to ask a question anytime!!



- 1) Portals  
Click on pink link to get to the next scene  
**CAREFUL: Not possible to get back - wait till the group goes**



- 2) Media  
Right click to make media full screen - then close using x



# Large tour

Left: InstaX 3

ATLAS experiment

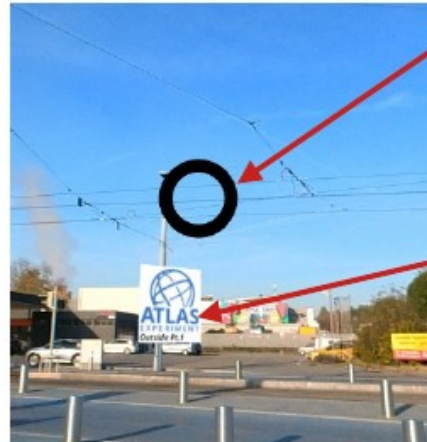
- 2\_OutsideP1
- 3\_ControlRoom
- 4\_VisitorsCentre
- 5\_EntryCavern
- 6\_LiftUpstairs
- 7\_LiftDownstairs
- 8\_Toilet
- 9\_W4FromLift
- 10\_W4Opposite
- 11\_W2\_ECOpposite
- 12\_W2BacksideDet
- 13\_TopView
- 14\_U0TourView
- 15\_BeamPipe
- 16\_MuonSystem
- 17\_W2CableSide
- 18\_USAComputer

1\_Reception

CERN site

- 19\_B1Office
- 20\_R1
- 21\_OutsideR1
- 22\_OutsideB40
- 23\_InsideB40
- 24\_B40Office

setup



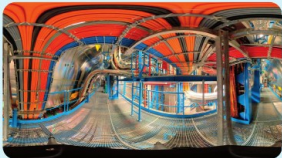
Line of sight → when hovering over a link will contract and “click”

Link to another scene

To go back: just use “back” arrow in browser



# Brochure



## 7 The Control Room

Back upstairs, there is the control room where the data taking is supervised. ATLAS comprises about 3000 scientists (including students), coming from 183 institutions around the world, representing 38 countries from all continents (except Antarctica). The collaboration also includes a lot of engineers, technicians and administrative staff.



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University of Sheffield  
Department of Physics and Astronomy  
Hicks Building, S3 7RH

In collaboration with:



## A Virtual Tour through the ATLAS Detector at CERN



### Explore one of the World's Largest Scientific Instruments



This virtual underground tour showcases the large ATLAS experiment.



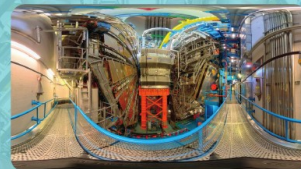
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## 2 Head to the Third Floor

On the 3rd floor, just two flights of stairs up and on the opposite side, we can see the detector a bit better. It has been opened and the cryostat has been moved out on orange support structures.

This very large cryostat contains the eight superconducting coils of the End Cap Toroid for the ATLAS magnets. When excited to the nominal current, 20,000 A flow (without resistance) in the superconducting coils.

Also, the Muon Wheel is visible in full glory. This large structure looks like a flower in full bloom with golden-coloured petals radiating outwards. It is designed to detect muons – particles that deposit so little energy that they are not stopped in the inner parts of the detector.



Discover ATLAS on the web!

## 3 Up to the Top!

Finally we reach the top. Look up at the shaft, a huge hole used to lower parts of the detector down for assembly. A nerve-racking experience: It takes hours as the large parts are carefully moved millimetre by millimetre. The shaft is very narrow, and smashing a unique and irreplaceable part into the concrete wall would be fatal.



## 4 The LHC Beampipe

Then we take a look at the LHC beampipe (blue pipe at the end of the alley). The beams in the LHC are made up of bunches of protons, spaced seven metres apart, with each one containing more than 100 billion protons. The silver plates are again parts of the muon detector (now seen from the other side)

